

SEGWAY HUMAN TRANSPORTER – INVESTIGATION INTO VIABILITY AS A MOBILITY DEVICE

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Background

Our interest in Segways originated almost two years ago when two of our clinicians saw a modern art display at a local gallery. The Segway was featured as an example of Industrial Design. The clinicians were excited about the prospect of using it as a mobility device for disabled people and came to our facility excited at the prospect of acquiring one. The idea met with a significant amount of resistance from fellow clinicians who felt that we shouldn't waste so much money on an untried commodity. It was suggested that we contact Segway and asked them to give us a sample to trial. Segway were not interested.



Dean Kamen allegedly designed the iBOT after seeing a young man in a wheelchair struggling to negotiate a curb. The iBOT was designed to negotiate uneven terrain and to allow the driver to have eye contact with standing individuals.

iBot manufacturing rights are licensed to Independence Technology a J and J company. The iBot has FDA approval as a power mobility device. It is in a unique category in that it requires a Dr's prescription and a period of formal training.

Using the Dynamic Stabilization technology developed for the iBOT Kamen then developed the Segway Human Transporter "the first self-balancing, electric-powered transportation device."



The Segway is not intended for people with disabilities and has not been submitted for FDA approval; the official line appears to be if you are disabled get an iBot. At a price of about \$40000US compared to around \$5000 for a Segway; not many people took them up on the suggestion.

How does it work?

The rider stands on a small platform supported 20 cm off the ground by two parallel wheels, and holds onto handlebars that have a control incorporated into the left grip used to steer the device. When the rider leans forward, the Segway moves forward and when the rider leans back the Segway stops or moves back. Virtual gyroscopes and other sensors constantly sense an individuals' centre of gravity and make minute adjustments to ensure a balanced and upright posture.

The Segway was intended for commuting, traveling around campus, community policing, delivering mail, etc.

However, lots of people with disabilities have chosen to purchase Segways with their own money and then deal with the issue of whether they can be driven legally in their hometown when and if they get questioned.

It is clear that Segway users are not limited by diagnosis. What was not clear however were the abilities needed to successfully use a Segway.

Why are we studying the Segway?

In Canada we do not require FDA approval for devices used by disabled people. Devices are sometimes funded on their applicability to individual situations. It is unclear what abilities a person would need to successfully and safely operate the Segway, we wanted to be informed when clients come to us with questions about using the Segway.

Inclusion criteria

50 subjects, 18 to 65 yrs old, proficient in English
 Sufficient cognitive capacity to follow instructions
 Able to walk a few steps either independently or with assistance
 Functional impairment that requires them to consider using an assistive device for mobility

Study Design

First visit includes an assessment by a physiotherapist to assess the client's ability in the following key areas:-

Cognitive Capacity Screening Test
 Berg Balance Scale
 Manual Muscle Strength Testing
 Grip Strength Testing
 Timed up and Go
 Questionnaire

An introduction to the Segway and half an hour practice.

Second visit; more practice and introduction to the tasks that will be tested in session three. Supervised by a physiotherapist.

Third visit; ability to safely use the Segway evaluated by a third party not involved in the training.

Protective gear is available, spotters are used and the clinicians involved are familiar with the Segway's handling characteristics.

Participants

Profile	
Number	23
Age range	21– 65 mean 45
Sex	15 m, 8 f
Time since Dx	7 mo's to 43 yrs

Disability	#
Amputee	2
SCI	6
CVA	6
MS	1
Guillain Barre	1
Rheumatoid Arthritis	1
Others	6

Primary Ambulation Aid	
Brace	1
Cane	4
Forearm crutches	4
Manual wheelchair	3
None	5
Prostheses	2
Walker	2

Ability

	Mean	Std dev	Range	Note
Muscle Strength				
Quad (left)	4.18	1.62	0-5	0 is flaccid, 5 is normal
Quad (right)	4.25	1.53	0-5	
Glutes (left)	3.61	1.45	0-5	
Glutes (right)	3.89	1.48	0-5	
Hamstrings (left)	3.28	1.44	0-5	
Hamstrings (right)	3.48	1.44	0-5	
Gastrocs (left)	3.38	1.4	0-5	
Gastrocs (right)	3.57	1.49	0-5	

	Mean	Std dev	Range	Note
Timed Up and Go				
(seconds)	19.1	19.2	7.9 - 93	Normal 8 seconds

	Mean	Std dev	Range	Note
Grip Strength				
Left	27.7	12.5	7.3 - 53.3	7.3 used L hand control
Right	32.1	14.6	0 - 56.7	

	Mean	Std dev	Range	Note
Berg Balance Score				
	42.13	15.08	7.0 - 56.0	Perfect score 56

Test

A Segway driver competence test was created to assess the subject's control of the device.

- 2 Yes
1 Somewhat
0 No

<input type="checkbox"/> Straight forward	<input type="checkbox"/> Straight backward
<input type="checkbox"/> Stand still	
<input type="checkbox"/> Turn right	<input type="checkbox"/> Turn left
<input type="checkbox"/> Follow a line* (basketball key) turning to the right	<input type="checkbox"/> Follow a line* (basketball key) turning to the left
<input type="checkbox"/> Uphill	<input type="checkbox"/> Downhill
<input type="checkbox"/> Through doorway (the one from Gym to hall near Ian's office)	<input type="checkbox"/> On grass* (figure 8 around trees - model the path first)
<input type="checkbox"/> Over rough terrain	<input type="checkbox"/> Down 3" curb
Optional Skills	<input type="checkbox"/> Up mat curb: 1 mat
<input type="checkbox"/> Up mat curb: 2 mats	<input type="checkbox"/> Up mat curb: 3 mats

Results

After testing 23 subjects our lowest score was 27 out of a possible 32. When only basic skills were considered, all subjects attained full marks except one who had a little difficulty holding the steering control on rough terrain and one who didn't try going up hill for some reason.

Discussion

Our subjects were all able to use the Segway despite their disabilities and the study was terminated after 23 people.

It is remarkable how easy it was for people to control the unit, despite significant disabilities. Brace walking para's with KAFO's and lesions as high as T5 love the device. Two complete SCI's with Berg scores as low as 7.0 / 56 scored 32/32. Others were successful with grip strength as low as 7.3

People's ability to accommodate for their disability makes it very difficult to determine a checklist of necessary skills. About the only concrete statement I can make following this project is - "Don't limit a clients potential just because you can't imagine them being able to do something, give it a try". Take precautions to minimize risk, but give it a try.

Future Studies

The study has been modified. Our initial question of "What abilities does a person need to be able to use a Segway" has been answered with the rather vague albeit encouraging phrase "Not much!"

Our next question is "Does the Segway provide a functional alternative mobility option for disabled individuals?" We will compare subject satisfaction with the Segway to the subjects other mobility devices while performing a self selected functional task using the WhOM tool developed by Bill Miller et al.